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New combinations in *Trichoderma* (*Hypocreaceae*, *Hypocreales*)

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Abstract — Unitary nomenclature demands the use of a single name for pleomorphic fungi determined according to priority. For this reason combinations in *Trichoderma* are here provided for 46 species for which such a combination is lacking. Although many more such species are known, only those are included here that are dealt with in more recent papers and where some DNA data are available in GenBank, even if erroneous; for other species it is strongly recommended to consult databases like Index Fungorum or MycoBank. Information on types is provided for most species, and representative cultures, GenBank accessions for *tef1* and *rpb2*, and important references are given for all species.

Key words — anamorph, *Ascomycota*, ICN, Kew rule, pyrenomycetes, teleomorph

Introduction

Hypocrea Fr. 1825 is the type and name-giving genus of the *Hypocreaceae*, *Hypocreales*. However, its anamorphic counterpart, *Trichoderma* Pers. 1794 : Fr. is older. The Melbourne Code of Nomenclature (ICN) dictates a unitary nomenclature, i.e., the use of a single name for a pleomorphic fungus, no matter whether ana- or teleomorphic, based either on priority or on commission-sanctioned decisions. The species of *Hypocrea*/*Trichoderma* are monophyletic and this is to be expressed in a single generic name. *Trichoderma* has priority over *Hypocrea* and is commonly used in commercial applications, e.g., cellulase production by *T. reesei*. A poll of individuals interested in the subject was taken by the International Subcommission on *Trichoderma* and *Hypocrea* (ISTH), which indicated a clear preference for adoption of *Trichoderma* over *Hypocrea*. Thus Rossman et al. (2013) proposed this generic name for acceptance by the Nomenclature Committee for Fungi (NCF) and the General Committee (GC) of the International Association for Plant Taxonomy (IAPT). However, a list of accepted names in *Trichoderma* has not yet been produced. There are some difficulties associated with this task. One example is the wide use

in commercial applications of *Trichoderma* epithets that are younger than the associated *Hypocrea* epithets, e.g., *T. reesei* / *H. jecorina* and *T. citrinoviride* / *H. schweinitzii*. Gams et al. (2012) suggested that authors establishing lists of protected names and the committees should apply the 'Kew rule' and accordingly "not recombine older epithets from a list-demoted genus into the list-accepted genus, when another one from pre-2013 is already available in that genus."

Index Fungorum lists 509 epithets in *Hypocrea*, including 55 names of varieties and forms (which have no priority at the species level). Many of these names do not represent members of this genus or are synonyms of other species of the genus, and the vast majority has never been re-assessed since their original description. Because of this large number of species names, it is strongly advisable for those who intend to describe new species to consult the Index of Fungi or databases like Index Fungorum or MycoBank, in order to avoid the creation of homonyms. At present, 219 *Trichoderma* epithets (including 9 varieties and forms) are listed in Index Fungorum. Many species have been re-assessed by several recent workers and others have been newly described in recent years. Jaklitsch et al. (2009, 2011), for example, established names in both *Hypocrea* and *Trichoderma* for species that are known to form an anamorph, but provided a name only in *Hypocrea* where no anamorph is known. In another example, Chaverri & Samuels (2003) did not establish names in *Trichoderma* for species earlier described in *Hypocrea* or for new species, where cultures did not survive storage. Such species as described in these works and several other recent papers (see below), are usually well characterized and also documented by molecular data. Therefore we provide here combinations in *Trichoderma* for these species as an intermediate step towards a list of accepted names in the genus *Trichoderma*.

The large number of species on one hand, the large number of isolates of many species on the other, and also the different portions of genes used as molecular-phylogenetic markers has made it difficult to select representative isolates and respective accessions for many species. For this reason we provide information on types, ex-type cultures, representative cultures and representative GenBank accessions for the most important markers, *rpb2* and *tef1*. We indicate also section or clade affinity for the species; when a formally established section is also supported by molecular phylogeny, we give preference to that designation.

Materials & abbreviations

All publications on the taxonomy and phylogeny of *Hypocrea* and/or *Trichoderma* that include molecular data were consulted and for species lacking an epithet in *Trichoderma*, information on types, ex-type or representative cultures was extracted. GenBank accessions for representative cultures were retrieved from the NCBI homepage (http://www.ncbi.nlm.nih.gov/). The following abbreviations are used in the

text: n.a. = not available, n.d. = not determined; phylog. = phylogenetic affinity; repres. = representative; sect. = section.

Results – data arrangement

New combinations in *Trichoderma* are proposed for *Hypocrea* names in species where such a combination is lacking. The 46 species treated here are (1) 41 for which DNA data are available and (2) 5 that are included because of confusing data. Additional data are given as: type information; repres. cultures; phylog. clade or section (plus short information on (atypical) anamorphs deviating from *Trichoderma* that form green conidia); repres. GenBank sequence accessions; important (recent) references.

Trichoderma albocorneum (Yoshim. Doi) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807413

≡ *Hypocrea albocornea* Yoshim. Doi, Bull. natn. Sci. Mus., Tokyo 15: 712 (1972).

Holotype: TNS-F-190171, ex-type culture: n.a.; possibly repres.: G.J.S. 97-28 (*tef1*: AY937440).

Phylog.: unknown; species with green ascospores. References: Doi (1972), Chaverri & Samuels (2003).

Trichoderma albofulvum (Berk. & Broome) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807414

≡ *Hypocrea albofulva* Berk. & Broome, J. Linn. Soc., Bot. 14: 113 (1873).

Holotype: n.d.; ex-type culture: n.a. The species is similar to *T. ochroleucum*.

Phylog.: sect. *Trichoderma*. Note: The species was described from Sri Lanka. The strains G.J.S. 01-234 (*tef1* accession: DQ846668) and/or G.J.S. 01-265 (*rpb2* accession: DQ835524) from material collected in Thailand may represent this species (see Jaklitsch 2011).

Trichoderma alcalifuscescens (Overton) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807415

≡ *Hypocrea alcalifuscescens* Overton, in Overton, Stewart & Geiser, Stud. Mycol. 56: 62 (2006).

Holotype: BPI 843638; isotype TAA(M) 181548; ex-type culture: CBS 122303 = TFC 2000-36.

Phylog.: unnamed clade; 'basal'; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860610; *rpb2*: DQ834462. Reference: Overton et al. (2006a), Jaklitsch (2011).

Trichoderma americanum (Canham) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807416

≡ *Hypocrea citrina* var. *americana* Canham, Mycologia 61: 320 (1969).

≡ *Hypocrea americana* (Canham) Overton, in Overton, Stewart, Geiser & Jaklitsch, Stud. Mycol. 56: 21 (2006).

Holotype: NY ex CUP 38045; ex-type culture: ATCC 18574; other repres. strains: CBS 123072 = G.J.S. 92-93, G.J.S. 96-191.

Phylog.: sect. *Hypocreanum*; anamorph acremonium-like, conidia hyaline. Repres. sequences: *tef1*: DQ835435 + DQ005523 + DQ835489; *rpb2*: DQ835455. Reference: Overton et al. (2006a).

Trichoderma andinense (Samuels & Petrini) Samuels, Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807417

≡ *Hypocrea andinensis* Samuels & Petrini, in Samuels, Petrini, Kuhls, Lieckfeldt & Kubicek, Stud. Mycol. 41: 13 (1998).

Holotype: BPI 1109854; ex-type culture: CBS 345.97 = G.J.S. 90-140 = ATCC 208857.

Phylog.: sect. *Longibrachiatum*. Repres. sequences: *tef1*: AY956321; *rpb2*: JN175531. References: Samuels et al. (1998, 2012).

Trichoderma atrogelatinosum (Dingley) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807418

≡ *Hypocrea atrogelatinosa* Dingley, Trans. Roy. Soc. New Zealand 83: 645 (1956).

Holotype: PDD 10471; ex-type culture: n.a..

Reference: Chaverri & Samuels (2003). Note: Status unclear. Several accessions are deposited in GenBank under the name *Hypocrea atrogelatinosa*; *rpb2* sequences (strains G.J.S. 88-28, 89-136, and 95-159) as well as *tef1* exon sequences belong to *T. ceraceum* (*H. ceracea*); however, *tef1* intron sequences vary considerably among these isolates.

Trichoderma avellaneum (Rogerson & S.T. Carey) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807419

≡ *Hypocrea avellanea* Rogerson & S.T. Carey, in Carey & Rogerson, Brittonia 28: 381 (1976).

Holotype: NY (MEBB 2471); isotype in K; ex-type culture: n.a.; repres. strain CBS 121667 = C.T.R. 77-155.

Phylog.: unknown, 'basal'; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: AY225857; *rpb2*: AF545562. Reference: Carey & Rogerson (1976).

Trichoderma britdaniae (Jaklitsch & Voglmayr) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807420

≡ *Hypocrea britdaniae* Jaklitsch & Voglmayr, Mycologia 104: 1216 (2012).

Holotype: K(M) 89878; ex-type culture: n.a. (ascospores not germinating).

Phylog.: sister to sect. *Longibrachiatum*; anamorph unknown. Repres. sequences (from stromata): *tef1*: JQ685865; *rpb2*: JQ685881. Reference: Jaklitsch & Voglmayr (2012).

Trichoderma caerulescens (Jaklitsch & Voglmayr) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807422

≡ *Hypocrea caerulescens* Jaklitsch & Voglmayr, in Jaklitsch, Stadler & Voglmayr, Mycologia 104: 928 (2012).

Holotype: WU 31600; ex-type culture: CBS 130011 = S195.

Phylog.: sect. *Trichoderma*. Repres. sequences: *tef1*: JN715621; *rpb2*: JN715604. Reference: Jaklitsch et al. (2012).

Trichoderma citrinum (Pers. : Fr.) Jaklitsch, W. Gams & Voglmayr, **comb. nov.**

MycoBank MB807423

≡ *Sphaeria citrina* Pers., Observ. mycol. (Lipsiae) 1: 68 (1796) : Fr.

≡ *Hypocrea citrina* (Pers. : Fr.) Fr., Summa veg. Scand., Section Post. (Stockholm): 383 (1849)

= *Sphaeria lactea* Fr., Kongl. Vetensk. Acad. Handl., n.s. 37: 141 (1816) : Fr.

≡ *Hypocrea lactea* (Fr. : Fr.) Fr., Summa veg. Scand., Section Post.: 383 (1849).

≡ *Trichoderma lacteum* (Fr. : Fr.) Bissett, Canad. J. Bot. 69: 2367 (1992 ["1991"]).

Neotype of *Trichoderma citrinum*: W. Gams 4031 (CBS); ex-type culture: CBS 894.85. Holotype of *Trichoderma lacteum*: DAOM 167644; ex-type culture CBS 853.70. Epitype of *Trichoderma lacteum*, **here designated**: W. Gams 4031 (CBS); ex-epitype culture: CBS 894.85.

Phylog.: sect. *Hypocreanum*; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860631, DQ835441; *rpb2*: FJ179603, AF545561. References: Overton et al. (2006a), Jaklitsch (2011).

Note: *Hypocrea citrina* is a well-known name for a well-known species, particularly in Europe, and has priority over *H. lactea*. Bissett (1992) erected the name *Trichoderma lacteum* for the anamorph of *H. lactea*. The *tef1* intron 5 of its ex-type strain CBS 853.70 clearly demonstrates conspecificity of *T. lacteum* with *T. citrinum*. The revised citation of *T. lacteum*, above, follows the working practice advocated by Hawksworth et al. (2013). Application of the 'Kew rule' would favour *T. lacteum* as the appropriate *Trichoderma* name for a synonymised *H. citrina*/*H. lactea*. However, this would be undesirable, because the inconsistent application of the name *H. lactea* to a number of different taxa could be misleading; for example, "*Hypocrea lactea*" sensu Doi (1972) was recently described as *T. pseudolacteum* by Kim et al. (2013).

Trichoderma corneum (Pat.) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807424

≡ *Hypocrea cornea* Pat., J. Bot. (Morot): 64 (1890).

Holotype: K; ex-type culture: n.a.

The cultures G.J.S. 97-82 (*tef1*: AY937435), G.J.S. 97-75 (*tef1*: AY937431) and G.J.S. 97-90 (*tef1*: AY937426) are isolates from specimens collected in Thailand. As the GenBank *tef1* accessions for these isolates vary considerably, fresh material from the original collecting region Tonkin, Vietnam, is necessary to judge which of them match the species. Phylog.: unclear; species with green ascospores. Reference: Chaverri & Samuels (2003).

Trichoderma costaricense (P. Chaverri & Samuels) P. Chaverri, Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807425

≡ *Hypocrea costaricensis* P. Chaverri & Samuels, Stud. Mycol. 48: 58 (2003).

Holotype: INB 0003527695; ex-type culture: P.C. 21 (lost after determination of DNA data).

Phylog.: Chlorospora clade, species with green ascospores. Repres. sequences: *tef1*: AY737741 + AY391980; *rpb2*: AY391921. Reference: Chaverri & Samuels (2003).

Trichoderma danicum (Jaklitsch) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807426

≡ *Hypocrea danica* Jaklitsch, Stud. Mycol. 63: 41 (2009).

Holotype: WU 29046; ex-type culture: CBS 121273 = C.P.K. 2448 = Hypo 402.

Phylog.: Spinulosa clade, species with green ascospores; anamorph not formed. Repres. sequences: *tef1*: FJ860634; *rpb2*: FJ860534. Reference: Jaklitsch (2009).

Trichoderma decipiens (Jaklitsch, K. Põldmaa & Samuels) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807427

≡ *Hypocrea decipiens* Jaklitsch, K. Põldmaa & Samuels, Mycologia 100: 981 (2008).

Holotype: BPI 747356; ex-type culture: CBS 121307 = G.J.S. 97-207; repres. G.J.S. 91-101.

Phylog.: sect. *Hypocreanum*; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860635, EF550995; *rpb2*: DQ835520. References: Jaklitsch et al. (2008), Overton et al. (2006b; as *Hypocrea farinosa*). Some further accessions can be retrieved under the name "*Hypocrea farinosa*", because the name has not been updated, pending consent by B. Overton.

Trichoderma eucorticioides (Overton) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807428

≡ *Hypocrea eucorticioides* Overton, in Overton, Stewart & Geiser, Stud. Mycol. 56: 55 (2006).

Holotype: LPS 1719; ex-type culture: n.a.; repres. G.J.S. 99-61 (lost).

Phylog.: sect. *Hypocreanum*; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: DQ835502 + DQ835474; *rpb2*: DQ835518. Reference: Overton et al. (2006b).

Trichoderma flaviconidium (P. Chaverri, Druzhin. & Samuels) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807429

≡ *Hypocrea flaviconidia* P. Chaverri, Druzhin. & Samuels, in Druzhinina, Chaverri, Fallah, Kubicek & Samuels, Stud. Mycol. 50: 404 (2004).

Holotype: INB 3862698; isotype BPI 746538; ex-type culture: G.J.S. 99-51 (dead); repres. G.J.S. 99-49, CBS 116238 = G.J.S. 99-57.

Phylog.: sect. *Trichoderma*, Hamatum subclade. Repres. sequences: *tef1*: DQ020001, AY665711; *rpb2*: EU883557. Reference: Druzhinina et al. (2004).

Trichoderma flavipes (Peck) Seifert, Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807430

≡ *Stilbum flavipes* Peck , Ann. Rep. N.Y. St. Mus. nat. Hist. 31: 45 (1879 ["1877"]).

≡ *Stilbella flavipes* (Peck) Seifert, Stud. Mycol. 27: 68 (1985).

= *Hypocrea cinereoflava* Samuels & Seifert, in Seifert & Samuels, Mycologia 89: 515 (1997).

Holotype of *Stilbum flavipes*: NYS; holotype of *Hypocrea cinereoflava*: BPI 802847; ex-teleotype culture: G.J.S. 92-102 = DAOM 222357.

Phylog.: unnamed clade, 'basal'; anamorph synnematous, stilbella-like in nature, conidia green. Repres. sequences: *tef1*: DQ834454; *rpb2*: DQ834461. Reference: Seifert & Samuels (1997); additional synonyms given in this publication.

Trichoderma foliicola (Jaklitsch & Voglmayr) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807431

≡ *Hypocrea foliicola* Jaklitsch & Voglmayr, Mycologia 104: 1218 (2012).

Holotype: WU 31611; ex-type culture: CBS 130008 = Hypo 645.

Phylog.: Pachybasium Core Group, conidia hyaline. Repres. sequences: *tef1*: JQ685862; *rpb2*: JQ685876. Reference: Jaklitsch & Voglmayr (2012).

Trichoderma hispanicum (Jaklitsch & Voglmayr) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807432

≡ *Hypocrea hispanica* Jaklitsch & Voglmayr, in Jaklitsch, Stadler & Voglmayr, Mycologia 104: 935 (2012).

Holotype: WU 31606; ex-type culture: CBS 130540 = S453.

Phylog.: sect. *Trichoderma*. Repres. sequences: *tef1*: JN715659; *rpb2*: JN715600. Reference: Jaklitsch et al. (2012).

Trichoderma hunua (Dingley) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807433

≡ *Hypocrea hunua* Dingley, Trans. & Proc. Roy. Soc. New Zealand 79(3–4): 327 (1952).

Holotype: PDD 10455; ex-type culture: n.a.; repres. CBS 238.63 (isolated: Dingley, No. 5).

Phylog.: Semiorbis clade. Repres. sequences: *tef1*: AF401011; *rpb2*: n.a. Reference: Kullnig-Gradinger et al. (2002).

Trichoderma lacuwombatense (B.S. Lu, Druzhin. & Samuels) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807434

≡ *Hypocrea lacuwombatensis* B.S. Lu, Druzhin. & Samuels, in Lu, Druzhinina, Fallah, Chaverri, Gradinger, Kubicek & Samuels, Mycologia 96: 338 (2004).

Holotype: PDD 77489; isotype BPI 746621; ex-type culture: CBS 122668 = G.J.S. 99-198.

Phylog.: Pachybasium Core Group. Repres. sequences: *tef1*: AY937452; *rpb2*: n.a. Reference: Lu et al. (2004).

Trichoderma megalocitrinum (Yoshim. Doi) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807435

≡ *Hypocrea megalocitrina* Yoshim. Doi, Bull. natn. Sci. Mus., Tokyo 15: 669 (1972).

Holotype: TNS-F-223220; isotype in NY; ex-type culture: n.a.; repres. BEO 00-09.

Phylog.: sect. *Hypocreanum*; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: AY225855 (exon); *rpb2*: AF545563. Reference: Overton et al. (2006a).

Trichoderma microcitrinum (Yoshim. Doi) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB MB807436

≡ *Hypocrea microcitrina* Yoshim. Doi, Bull. natn. Sci. Mus., Tokyo 15: 667 (1972).

Holotype: TNS-F-223325; ex-type culture: n.a.; repres. BPI 744660; repres. cultures G.J.S. 97-248, G.J.S. 91-61.

Phylog.: sect. *Hypocreanum*; anamorph acremonium- to verticillium-like, conidia hyaline. Repres. sequences: *tef1*: DQ835449 + DQ835479; *rpb2*: DQ835462. Reference: Overton et al. (2006a).

Trichoderma neorufum (Samuels, Dodd & Lieckf.) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807437

≡ *Hypocrea neorufa* Samuels, Dodd & Lieckf., in Dodd, Lieckfeldt, Chaverri, Overton & Samuels, Mycol. Prog. 1: 421 (2002).

Holotype: BPI 744493; ex-type culture: CBS 111144 = G.J.S. 96-135; repres. CBS 119498.

Phylog.: sect. *Trichoderma*. Repres. sequences: *tef1*: FJ860653; *rpb2*: FJ860550. References: Dodd et al. (2002), Jaklitsch (2011).

Trichoderma novae-zelandiae (Samuels & Petrini) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807438

≡ *Hypocrea novae-zelandiae* Samuels & Petrini, in Samuels, Petrini, Kuhls, Lieckfeldt & Kubicek, Stud. Mycol. 41: 25 (1998).

Holotype: PDD 46792; ex-type cultures: CBS 496.97 and CBS 639.92 = G.J.S. 81-265 = ATCC 208856.

Phylog.: sect. *Longibrachiatum*. Repres. sequences: *tef1*: AY865639, AY937448; *rpb2*: JN133563. References: Samuels et al. (1998, 2012), Druzhinina et al. (2012).

Trichoderma nybergianum (T. Ulvinen & H.L. Chamb.) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807439

≡ *Hypocrea nybergiana* T. Ulvinen & H.L. Chamb., in Chamberlain, Rossman, Stewart, Ulvinen & Samuels, Karstenia 44: 21 (2004).

Holotype: OULU F 49597; isotype OULU F 49596; ex-type culture: n.a.; repres. CBS 122500 = C.P.K. 3159 = Hypo 572, CBS 122496 = C.P.K. 3163 = Hypo 577.

Phylog.: Pachybasium Core Group, conidia hyaline. Repres. sequences: *tef1*: FJ179575; *rpb2*: FJ179611. References: Chamberlain et al. (2004), Jaklitsch (2011).

Trichoderma ochroleucum (Berk. & Ravenel) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807440

≡ *Hypocrea ochroleuca* Berk. & Ravenel, in Berkeley, Grevillea 4: 14 (1875).

Holotype: K(M) 56075; ex-type culture: n.a.; repres. CBS 119502 = C.P.K. 1895 = Hypo 274.

Phylog.: sect. *Trichoderma*. Repres. sequences: *tef1*: FJ860659; *rpb2*: FJ860556. Reference: Jaklitsch (2011). Note: GenBank accessions for G.J.S. 01-234 and G.J.S. 01-265 may represent *Trichoderma albofulvum* (see above).

Trichoderma orientale (Samuels & Petrini) Jaklitsch & Samuels, **comb. nov.**

MycoBank MB807441

≡ *Hypocrea orientalis* Samuels & Petrini, in Samuels, Petrini, Kuhls, Lieckfeldt & Kubicek, Stud. Mycol. 41: 30 (1998).

Holotype: BPI 1109853; ex-type culture: CBS 130428 = G.J.S. 88-81, repres. CBS 131488, G.J.S. 09-784.

Phylog.: sect. *Longibrachiatum*. Repres. sequences: *tef1*: EU401581, JN175573, JQ685868; *rpb2*: JN175522, JQ685884. References: Samuels et al. (1998, 2012).

Trichoderma parapiluliferum (B.S. Lu, Druzhin. & Samuels) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807442

≡ *Hypocrea parapilulifera* B.S. Lu, Druzhin. & Samuels, in Lu, Druzhinina, Fallah, Chaverri, Gradinger, Kubicek & Samuels, Mycologia 96: 331 (2004).

Holotype: BPI 112832; ex-type culture: CBS 112771 = G.J.S. 91-60; repres. CBS 120921 = C.P.K. 1908.

Phylog.: Pachybasium Core Group, conidia hyaline. Repres. sequences: *tef1*: FJ179578, AY937444; *rpb2*: FJ179614. References: Lu et al. (2004), Jaklitsch (2011).

Trichoderma parmastoi (Overton) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807443

≡ *Hypocrea parmastoi* Overton, in Overton, Stewart & Geiser, Stud. Mycol. 56: 62 (2006).

Holotype: BPI 843639; isotype TAA(M) 169055; ex-type culture: TFC 97-143; repres. CBS 121139.

Phylog.: sect. *Hypocreanum*; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860668, DQ834456 (exon); *rpb2*: FJ860567, DQ834463. References: Overton et al. (2006b), Jaklitsch (2011).

Trichoderma patella (Cooke & Peck) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807444

≡ *Hypocrea patella* Cooke & Peck, in Peck, Ann. Rep. N.Y. St. Mus. nat. Hist. 29: 57 (1878 ["1875"]).

Holotype: NYS; isotype: BPI 631626; ex-type culture: n.a.; repres. CBS 110082 = G.J.S. 95-173, CBS 110084 = G.J.S. 96-198 = ATCC 208855.

Phylog.: unknown, remotely associated with sect. *Longibrachiatum*. Repres. sequences: *tef1*: AY937428; *rpb2*: n.a.. Reference: Dodd et al. (2002).

Trichoderma peltatum (Berk.) Samuels, Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807511

≡ *Sphaeria peltata* Jungh., Verh. Batav. Genootsch. Kunst. Wet. 17(3): 20 (1838), nom. illegit., non DC. 1805.

≡ *Hypocrea peltata* Berk., Hooker's J. Bot. Kew Gard. Misc. 3: 205 (1851).

Holotype: L 00532089 (Junghuhn 103); ex-type culture: n.a.; repres. CBS 127107 = G.J.S. 09-1550, CBS 127115 = G.J.S. 08-207, G.J.S. 10-103, G.J.S. 10-104, G.J.S. 10-105, CBS 120951.

Phylog.: unnamed clade, close to *T. sambuci* and *T. tremelloides*; anamorph not formed. Repres. sequences: *tef1*: n.a.; *rpb2*: HQ260609, HQ260610. Reference: Samuels & Ismaiel (2011).

Note: The original name of this taxon, *Sphaeria peltata*, is an illegitimate later homonym and cannot act as basionym for new combinations (ICN Art. 6.10). The basionym is the earliest legitimate name, *Hypocrea peltata* Berk. 1851, which is to be treated as a replacement name for the illegitimate *S. peltata* (ICN 58.1).

Trichoderma pezizoides (Berk. & Broome) Samuels, Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807445

≡ *Hypocrea pezizoides* Berk. & Broome, J. Linn. Soc., Bot. 14(74): 112 (1873).

Holotype: n.d.; ex-type culture: n.a.; ?repres.: CBS 101131 = G.J.S. 97-83 = C.P.K. 775, G.J.S. 01-231 (Thailand). Originally described from Sri Lanka.

Phylog.: sect. *Trichoderma*. Repres. sequences: *tef1*: AY225859; *rpb2*: JN715610, AF545564. Reference: Atanasova et al. (2013).

Trichoderma protopulvinatum (Yoshim. Doi) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807446

≡ *Hypocrea protopulvinata* Yoshim. Doi, Bull. natn. Sci. Mus., Tokyo 15: 695 (1972).

Holotype: TNS-F-223421; isotype NY 00965650; ex-type culture: CBS 739.83; repres. C.P.K. 2434, CBS 121274 = C.P.K. 2430.

Phylog.: sect. *Hypocreanum*; anamorph acremonium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860676; *rpb2*: FJ860574. References: Overton et al. (2006a), Jaklitsch (2011).

Trichoderma pulvinatum (Fuckel) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807447

≡ *Hypocrea pulvinata* Fuckel, Jb. nassau. Ver. Naturk. 23–24: 185 (1870).

Lectotype: FH 00284789 (Fuckel 876); ex-type culture: n.a.; repres. CBS 121279.

Phylog.: sect. *Hypocreanum*; anamorph acremonium- to verticillium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860683; *rpb2*: FJ860577. References: Overton et al. (2006a), Jaklitsch (2011).

Trichoderma rhododendri (Jaklitsch & Voglmayr) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807448

≡ *Hypocrea rhododendri* Jaklitsch & Voglmayr, in Jaklitsch, Fungal Diversity 48: 199 (2011).

Holotype: WU 29442 (Hypo 209); ex-type culture: CBS 119288 = C.P.K. 2015.

Phylog.: Psychrophila clade, anamorph unknown. Repres. sequences: *tef1*: FJ860685; *rpb2*: FJ860578. Reference: Jaklitsch (2011).

Trichoderma rodmanii (Samuels & P. Chaverri) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807449

≡ *Hypocrea rodmanii* Samuels & P. Chaverri, Mycol. Prog. 7: 213 (2008).

Holotype: BPI 1112859; ex-type culture: CBS 120895 = G.J.S. 91-88; repres. CBS 121553.

Phylog.: Brevicompactum clade. Repres. sequences: *tef1*: FJ860687, EU338286; *rpb2*: FJ860580, EU338324. References: Degenkolb et al. (2008), Jaklitsch (2011).

Trichoderma sambuci (Jaklitsch & Voglmayr) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807450

≡ *Hypocrea sambuci* Jaklitsch & Voglmayr, in Jaklitsch, Fungal Diversity 48: 213 (2011).

Holotype: WU 29463 (Hypo 198); ex-type culture: n.a.; repres. CBS 126958 = S 94.

Phylog.: unnamed clade, close to *T. tremelloides*; conidia hyaline. Repres. sequences (based on DNA from the specimen WU 29467 = Hypo 426): *tef1*: FJ860693; *rpb2*: FJ860585. Reference: Jaklitsch (2011).

Trichoderma semiorbis (Berk.) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807451

≡ *Sphaeria semiorbis* Berk., J. Bot. (Hooker) 2: 146 (1840).

≡ *Hypocrea semiorbis* (Berk.) Berk., in Hooker, Fl. Tasman. 2: 278. (1859 ["1860"]).

Holotype: K; ex-type culture: n.a.; repres. CBS 244.63 = DAOM 167636, G.J.S. 99-108, G.J.S. 99-109.

Phylog.: Semiorbis clade; conidia hyaline. Repres. sequences: *tef1*: AF545568; *rpb2*: JN133567, AF545522. Reference: Chaverri et al. (2003).

Trichoderma spinulosum (Fuckel) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807452

≡ *Hypocrea spinulosa* Fuckel, Jb. nassau. Ver. Naturk. 23–24: 184 (1870).

Holotype: Fuckel (G); ex-type culture: n.a.; repres. CBS 310.50, CBS 311.50 = C.P.K. 1510, CBS 121272 = C.P.K. 2464.

Phylog.: Spinulosa clade, species with green ascospores; anamorph not formed. Repres. sequences: *tef1*: FJ860701; *rpb2*: FJ860591. References: Chaverri & Samuels (2003), Jaklitsch (2009).

Trichoderma stellatum (B.S. Lu, Druzhin. & Samuels) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807453

≡ *Hypocrea stellata* B.S. Lu, Druzhin. & Samuels, in Lu, Druzhinina, Fallah, Chaverri, Gradinger, Kubicek & Samuels, Mycologia 96: 333 (2004).

Holotype: PDD 77488; ex-type culture: CBS 112265 = G.J.S. 99-122 (as 'G.J.S. 99-222' in GenBank).

Phylog.: Pachybasium Core Group, conidia hyaline. Repres. sequences: *tef1*: AY937445, AY240855 (intron5 only); *rpb2*: n.a. Reference: Lu et al. (2004).

Trichoderma subsulphureum (Syd.) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807454

≡ *Hypocrea subsulphurea* Syd., in De Wildeman, Études Fl. Bas- Moyen-Congo 3: 15 (1909).

Holotype: ?lost; ex-type culture: n.a.; ?repres. M141 (?BPI).

Phylog.: sect. *Hypocreanum*; anamorph verticillium-like, conidia hyaline. Repres. sequences (from teleomorph of M141): *tef1*: DQ835492; *rpb2*: DQ835522. Reference: Overton et al. (2006b).

Trichoderma sulawesense (Yoshim. Doi) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807455

≡ *Hypocrea sulawesensis* Yoshim. Doi, in Samuels, Doi & Rogerson, Mem. N. Y. bot. Gdn 59: 23 (1990).

Holotype: BO; isotypes NY 01169121, NY 00967625, TNS-F-243769, ex-type culture: G.J.S. 2006 (lost), repres. G.J.S. 85-228.

Phylog.: unnamed clade; species with green ascospores; anamorph forming elongate hyaline phragmoconidia in addition to green unicellular conidia. Repres. sequences: *tef1*: AY737730 + AY392002; *rpb2*: AY391954. Reference: Chaverri & Samuels (2003).

Trichoderma sulphureum (Schwein.) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807456

≡ *Sphaeria sulphurea* Schwein., Trans. Amer. philos. Soc., Ser. 2, 4 (2): 193 (1832).

≡ *Hypocrea sulphurea* (Schwein.) Sacc., Syll. Fung. (Abellini) 2: 535 (1883).

Holotype: n.d.; isotype: K, ex herb Schweinitz; not epitypified; ex-type culture: n.a.; repres. C.P.K. 1593, CBS 119929 = C.P.K. 1598.

Phylog.: sect. *Hypocreanum*; anamorph acremonium- to verticillium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860709; *rpb2*: FJ860599. References: Overton (2006b), Jaklitsch (2011).

Trichoderma victoriense (Overton) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807457

≡ *Hypocrea victoriensis* Overton, in Overton, Stewart & Geiser, Stud. Mycol. 56: 55 (2006).

Holotype: BPI 747361; ex-type culture: G.J.S. 99-200; repres. C.P.K. 3565.

Phylog.: sect. *Hypocreanum*; anamorph verticillium-like, conidia hyaline. Repres. sequences: *tef1*: FJ860718; *rpb2*: DQ835517. Reference: Overton et al. (2006b).

Trichoderma virescentiflavum (Speg.) Jaklitsch & Voglmayr, **comb. nov.**

MycoBank MB807458

≡ *Hypocrea virescentiflava* Speg., Boln Acad. nac. Cienc. Córdoba 11: 529 (1889).

Holotype: LPS 1726 (J. Puiggari 2353), ex-type culture: n.a.; repres. P.C. 278 (lost after determination of DNA data).

Phylog.: Virescentiflava clade, species with green ascospores. Repres. sequences: *tef1*: AY737749 + AY392007; *rpb2*: AY391959. Reference: Chaverri & Samuels (2003).

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